

I-77 Feasibility Study (I-85 to Griffith Street)

TIP Project No. FS-0810B

Task Order No. 1 – I-77 HOV Extension

Sub-task 1.E: Capital, Operations & Maintenance Costs

TECHNICAL MEMORANDUM

(FINAL)

December 7, 2009

1.0 INTRODUCTION

This memorandum details capital, operations and maintenance (O&M) assumptions and preliminary cost estimates for extending the existing high-occupancy vehicle (HOV) lanes along I-77 northward to Griffith Street at Davidson (Exit 30). While the memorandum provides capital construction costs for different widening scenarios, only O&M costs for the HOV lane are included. The information contained in this memo has been collected from sources at the North Carolina Department of Transportation (NCDOT) and its business unit, the North Carolina Turnpike Authority (NCTA), which have experience with similar freeway and toll facilities. Information from similar projects being implemented or developed nationally were used in lieu of local information where data gaps existed.

O&M costs for the roadway, including additional costs that enhance the level of service on the facility, such as added safety and enforcement patrols, are covered in this memo. In addition to initial construction expenses, capital maintenance needs for the roadway are also covered. For all scenarios, the costs presented in this memorandum represent what would be needed to maintain a level of service (including roadside assistance, roadway condition, and traffic flow) that exceeds the level typically maintained on State highways.

The corridor's existing HOV facility extends from Hambright Road to Oaklawn Avenue in the southbound direction and from Cindy Lane to I-485 in the northbound direction. It is possible under various scenarios that the HOV lanes will be extended to Exit 25 (Sam Furr Road), Exit 28 (Catawba Avenue) or to Exit 31 (Langtree Road). Because HOV operational data will be presented for the existing facility and these two extension scenarios, **Table 1-1** shows the length of each of these facilities.

All corridor scenarios will have one HOV lane in each direction; therefore, lane-miles and directional-miles of the facilities are the same. The roadway layout for the HOV lane is assumed to be a narrow buffer-separated concurrent-flow system, meaning one dedicated lane will be available in each direction at all times and will be separated from general purpose lanes by pavement markings, rather than concrete or plastic barriers.

Table 1-1: HOV Scenarios

	Per Segment	Cumulative
	Lane Miles	Lane Miles
Existing HOV Lanes	13.2	13.2
Extension to Exit 25	10.5	23.7
Extension to Exit 28	5.8	29.5
Extension to Exit 30	3.0	32.5
Total System	32.5	

* Designates a single directional tolling point

To account for expected inflation, annual escalation rates of 3 percent and 5 percent are used for general and construction inflation, respectively. Unless otherwise noted, all figures presented herein were escalated or discounted to 2009 dollars. A roadway cost

contingency of 20 percent is included to account for price fluctuations and unforeseen expenses.

2.0 CAPITAL COSTS

2.1 CONSTRUCTION COSTS

2.1.1 Methodology Overview

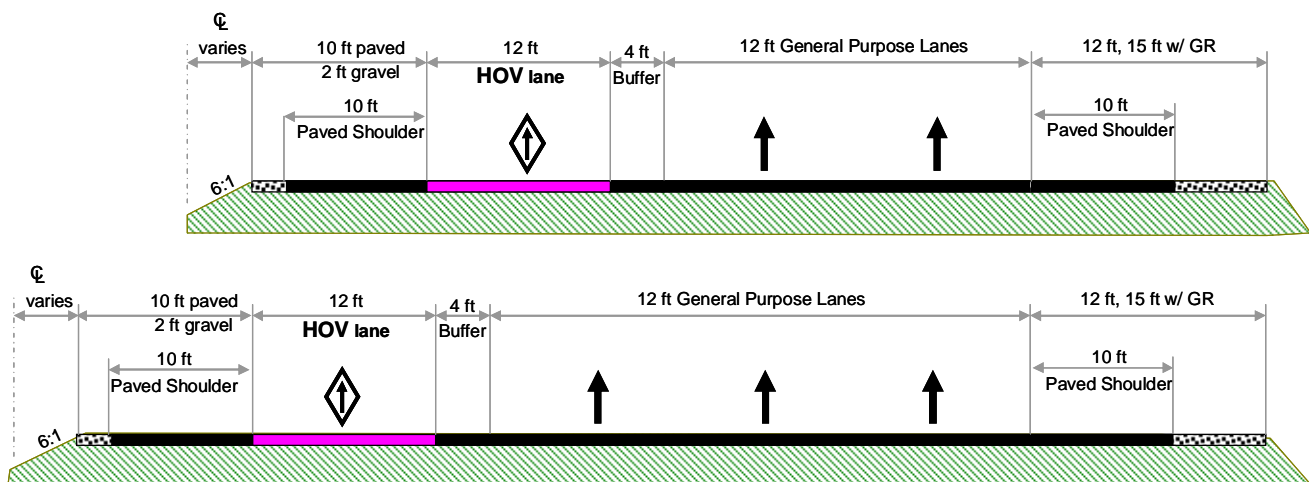
Based on the functional design, construction cost estimates for extending the existing I-77 HOV facility used cost data from NCDOT's latest preliminary estimates construction cost index, and estimates are provided in current year dollars. NCDOT staff reviewed the construction cost estimates, projected major quantities, and unit prices.

Estimates were prepared for two build options considered under this task order:

- Extend the existing HOV lane in both directions north to Catawba Avenue (Exit 28) and keep the existing general purpose lane cross section. This will provide three lanes in each direction. About a half-mile south of Exit 28, the northbound HOV lane would lose its designation and the outside general purpose lane would be dropped at Catawba Avenue (Exit 28). The southbound HOV lane begins between Exits 28 and 30, south of the causeway.
- Implement the above improvements and add another general purpose lane in each direction between I-485 and Catawba Avenue (Exit 28). This will provide four lanes in each direction and match the cross section where the HOV lane currently exists south of I-485. At Exit 28, the HOV lane will lose its designation and the outside general purpose lane would be dropped at the on-ramp for this interchange. Another general purpose lane would be dropped at Langtree Road (Exit 31) in order to match the existing I-77 lane configuration north of this interchange.

Figure 2-1 compares the typical cross section in which just the HOV lanes are extended north with the cross section that includes the addition of both the HOV facility and general purpose lanes.

Figure 2-1: Typical Cross Sections



The following roadway design principles were assumed for I-77 improvements:

- Widening for both alternates will be in the median where space is available. Only when sufficient space is not available, additional widening will occur on the outside.
- Overlay of existing facility will be required as part of the construction of any new lanes.
- No design exceptions are required under either option. A minimum of 12-foot lanes will be used with standard shoulders.
- All existing interchange and overpass structures can remain.
- No additional right-of-way is needed for freeway widening.
- No significant impacts on utilities are anticipated.
- Signing will be implemented based on the latest MUTCD guidelines for HOV facilities.

2.1.2 Construction Cost Estimates

Preliminary cost estimates have been prepared using NCDOT's functional design cost estimate index. All estimates are based on the functional design prepared for each alternative. In addition, a signing plan was developed based on the latest MUTCD guidelines and included in the estimate. The following tables show cost breakdown as follows:

Table 2-1 and **Table 2-2** summarize the construction costs estimated for the option of HOV facility extension only by two segments: 1) north to NC-73 or Sam Furr Road (Exit 25) and 2) between Exit 25 and Langtree Road (Exit 31). All costs are expressed in 2009 dollars.

Table 2-3 and **Table 2-4** indicate estimated construction costs for the same two segments for the alternative which adds two lanes in both directions of I-77.

Table 2-5 shows that extension of the HOV lanes north of the current terminus in Huntersville could cost between \$38 million and \$74 million depending on decisions related to the endpoint of the HOV lane extension and addition of another general purpose lane in each direction.

Table 2-1: HOV Lane Extension Only
(Mt. Holly-Huntersville Rd. to NC-73)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	50.2	Acre	\$ 12,000.00	\$ 602,400.00
			Earthwork	58,700	CY	\$ 8.00	\$ 469,600.00
			Drainage Existing Location	3.60	Miles	\$ 250,000.00	\$ 900,000.00
			Fine Grading	150,800	SY	\$ 1.50	\$ 226,200.00
			Pavement Widening	108,900	SY	\$ 52.00	\$ 5,662,800.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	142,400	SY	\$ 7.00	\$ 996,800.00
			___" Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	108,900	SY	\$ 6.00	\$ 653,400.00
			Conc. Barrier Wall	0	LF	\$ 80.00	\$ -
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			Fencing				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	79.6	Acres	\$ 12,000.00	\$ 955,200.00
			Signing Interchanges				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOV Signing	1.0	Each	\$ 185,000.00	\$ 185,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	3.6	Miles	\$ 350,000.00	\$ 1,260,000.00
			Thermo and Markers	3.6	Miles	\$ 30,000.00	\$ 108,000.00
			Structures				
			ML / Creek ___'Wx ___'L	0.00	SF		\$ -
			RC Box Culverts				
			Ex. 3@10x10-50'Extension-3'Fill-90'Skew		LF		
			Utility Construction				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)				
			Misc. & Mob (45% Functional)	1	LS		\$ 5,410,000.00
Lgth 3.6 Miles			Contract Cost				\$ 17,429,400.00
			E. & C. 15%				\$ 2,614,410.00
			Construction Cost				\$ 20,043,810.00

Table 2-2: HOV Lane Extension Only
(NC-73 to Langtree Road)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	43.5	Acre	\$ 12,000.00	\$ 522,000.00
			Earthwork	50,900	CY	\$ 8.00	\$ 407,200.00
			Drainage Existing Location	3.10	Miles	\$ 250,000.00	\$ 775,000.00
			Fine Grading	130,800	SY	\$ 1.50	\$ 196,200.00
			Pavement Widening	94,500	SY	\$ 52.00	\$ 4,914,000.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	123,500	SY	\$ 7.00	\$ 864,500.00
			1" Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	94,500	SY	\$ 6.00	\$ 567,000.00
			Conc. Barrier Wall	3,200	LF	\$ 80.00	\$ 256,000.00
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			Fencing				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	69.0	Acres	\$ 12,000.00	\$ 828,000.00
			Signing Interchanges				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOV Signing	1.0	Each	\$ 175,000.00	\$ 175,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	3.10	Miles	\$ 350,000.00	\$ 1,085,000.00
			Thermo and Markers	3.10	Miles	\$ 30,000.00	\$ 93,000.00
			Structures				
			ML / Creek ____'Wx ____'L	0.00	SF		\$ -
			RC Box Culverts				
			Ex. 3@10x10-50'Extension-3'Fill-90Ske	36	LF	\$ 3,000.00	\$ 108,000.00
			Utility Construction				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)	1	LS		\$ 16,500.00
			Misc. & Mob (45% Functional)	1	LS		\$ 4,810,000.00
Lgth 3.1 Miles			Contract Cost				\$ 15,617,400.00
			E. & C. 15%				\$ 2,342,610.00
			Construction Cost				\$ 17,960,010.00

Table 2-3: HOV Lane and Additional General Purpose Lane in each Direction
(North of Hambright Rd. to NC-73)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	73.1	Acre	\$ 12,000.00	\$ 877,200.00
			Earthwork	98,400	CY	\$ 8.00	\$ 787,200.00
			Drainage Existing Location	4.50	Miles	\$ 250,000.00	\$ 1,125,000.00
			Fine Grading	238,700	SY	\$ 1.50	\$ 358,050.00
			Pavement Widening	186,300	SY	\$ 52.00	\$ 9,687,600.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	177,900	SY	\$ 7.00	\$ 1,245,300.00
			--- "Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	186,300	SY	\$ 6.00	\$ 1,117,800.00
			Conc. Barrier Wall	0	LF	\$ 80.00	\$ -
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			Fencing				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	110.0	Acres	\$ 12,000.00	\$ 1,320,000.00
			Signing Interchanges				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOV Signing	1.0	Each	\$ 185,000.00	\$ 185,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	4.50	Miles	\$ 450,000.00	\$ 2,025,000.00
			Thermo and Markers	4.50	Miles	\$ 40,000.00	\$ 180,000.00
			Structures				
			ML / Creek ---'Wx ---'L	0.00	SF		\$ -
			RC Box Culverts				
			Ex. 3@10x10-50'Extension-3'Fill-90Skew		LF		
			Utility Construction				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)				
			Misc. & Mob (45% Functional)	1	LS		\$ 8,508,700.00
Lgth 4.5 Miles			Contract Cost				\$ 27,416,850.00
			E. & C. 15%				\$ 4,112,527.50
			Construction Cost				\$ 31,529,377.50

Table 2-4: HOV Lane and Additional General Purpose Lane in each Direction
(NC-73 to Langtree Road)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	68.2	Acre	\$ 12,000.00	\$ 818,400.00
			Earthwork	117,600	CY	\$ 8.00	\$ 940,800.00
			Drainage Existing Location	6.00	Miles	\$ 250,000.00	\$ 1,500,000.00
			Fine Grading	260,400	SY	\$ 1.50	\$ 390,600.00
			Pavement Widening	221,000	SY	\$ 52.00	\$ 11,492,000.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	239,500	SY	\$ 7.00	\$ 1,676,500.00
			___ "Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	221,000	SY	\$ 6.00	\$ 1,326,000.00
			Conc. Barrier Wall	31,700	LF	\$ 80.00	\$ 2,536,000.00
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			Fencing				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	118.0	Acres	\$ 12,000.00	\$ 1,416,000.00
			Signing Interchanges				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOV Signing	1.0	Each	\$ 215,000.00	\$ 215,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	6.00	Miles	\$ 450,000.00	\$ 2,700,000.00
			Thermo and Markers	6.00	Miles	\$ 40,000.00	\$ 240,000.00
			Structures				
			ML / Creek ___'Wx ___'L	0.00	SF		\$ -
			RC Box Culverts				
			Ex. 3@10x10-50'Extension-3'Fill-90Ske	60	LF	\$ 3,000.00	\$ 180,000.00
			Utility Construction				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)	1	LS		\$ 27,500.00
			Misc. & Mob (45% Functional)	1	LS		\$ 11,370,000.00

Lgth 6.0 Miles	Contract Cost	\$ 36,828,800.00
	E. & C. 15%	\$ 5,524,320.00
	Construction Cost	\$ 42,353,120.00

Table 2-5: Summary of Costs

Alternative 1: HOV Lane Only	Cost in 2009 Dollars	Alternative 2: HOV + GP Lane	Cost in 2009 Dollars
Mt. Holly- Hunterville to NC- 73	\$ 20,000,000	North of Hambright Rd. to NC-73	\$ 31,500,000
NC-73 to Catawba Avenue	\$ 18,000,000	NC-73 to Langtree Road	\$ 42,400,000
TOTAL	\$ 38,000,000	TOTAL	\$ 73,900,000

2.2 ROADWAY CAPITAL MAINTENANCE COSTS

In addition to initial construction costs, major renovation and rehabilitation costs (sometimes categorized as capital maintenance expenditures) have been estimated. Facility capital maintenance costs are presented to illustrate the amount of funds that could be needed over time to keep the HOV lane in optimal condition. The costs outlined in **Table 2-6** are for two cycles of capital maintenance that should keep the roadway in good condition for over 30 years. The first capital maintenance project would be needed when the lane is about 12 years old. This project will consist of a surface seal to fill cracks in the roadway and re-establish the surface texture. The second capital maintenance project would be needed when the lane is about 24 years old, and would involve milling the surface of the roadway off and replacing it with a two-inch overlay of new pavement.

Table 2-6: Periodic Capital Maintenance Costs (2009 Dollars)

	Unit Cost (per lane mile)	Frequency (years)	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Surface Sealing	\$50,000	12	\$ 792,000	\$ 630,000	\$ 348,000	\$ 180,000	\$ 1,950,000
Mill & Overlay	\$70,000	24	\$1,108,800	\$ 882,000	\$ 487,200	\$ 252,000	\$ 2,730,000
Cumulative Costs			\$1,108,800	\$ 1,990,800	\$ 2,478,000	\$ 2,730,000	

* Contingency of 20% included

The mill and overlay would provide adequate roadway surface for an additional 12 years, though during this time, the roadway's sub-surface would begin to break down and eventually the entire roadway would need to be replaced (approximately 30 to 35 years from initial construction). Escalating the figures in **Table 2-6** at a rate of 5 percent to the appropriate years when these projects would be undertaken would increase the costs considerably. For instance, if the full 32.5-mile system was completed in 2012, the cost to do a surface sealing 12 years later in 2024 would be about \$4.1 million in year-of-expenditure dollars.

3.0 OPERATIONS & MAINTENANCE COSTS

3.1 ROADWAY O&M COSTS

Roadway O&M cost estimates are based on a current NCDOT estimate of about \$9,000 per lane-mile per year. This cost would cover surface upkeep, sign repair, snow removal, fence repair, landscaping and other related expenses. **Table 3-1** summarizes the annual roadway O&M costs for each HOV scenario.

Table 3-1: Roadway O&M Costs (2009 Dollars)

	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Roadway Maintenance	\$118,800	\$94,500	\$52,200	\$27,000	\$ 292,500
Contingency (20%)	\$23,760	\$18,900	\$10,440	\$5,400	\$ 58,500
Total Cost	\$142,560	\$113,400	\$62,640	\$32,400	\$ 351,000
Cumulative Costs	\$142,560	\$255,960	\$318,600	\$351,000	

3.2 ENFORCEMENT & COURTESY PATROL

The average cost for an enforcement patrol was estimated at \$105,000 per year based on input from the North Carolina State Highway Patrol (NCSHP). The equivalent of a patrol assigned to the corridor 50 percent of the time of HOV lane operations will be needed to monitor vehicle occupancy and the weaving in and out of the HOV lane where access is prohibited.

In addition to expanded enforcement, supplemental incident response service should be budgeted. For the Triangle Expressway, NCTA has contracted with the NCDOT's Incident Management Assistance Patrol (IMAP) for these services. NCTA's proposed contract for IMAP services equals about \$11,400 per lane mile annually. A unit cost of 80 percent of this estimate was assumed for the I-77 corridor because service is already being provided and the cost to increase service frequency would be less than operating service where it had not been previously provided. A unit cost of \$9,200 per year per lane-mile was assumed for IMAP service along the HOV lane facilities, as illustrated in **Table 3-2**.

Table 3-2: Patrol Costs (2009 Dollars)

	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Enforcement	\$52,500	NA	NA	NA	\$ 52,500
IMAP Payment	\$121,800	\$96,900	\$53,500	\$27,700	\$ 299,900
Contingency (15%)	\$26,100	\$14,500	\$8,000	\$4,200	\$ 52,800
Total Cost	\$200,400	\$111,400	\$61,500	\$31,900	\$ 405,200
Cumulative Costs	\$200,400	\$311,800	\$373,300	\$405,200	

3.3 TOTAL OPERATIONS & MAINTENANCE COSTS

Table 3-3 summarizes the major categories of O&M costs outlined in the above sections providing a total for each HOV facility scenario.

Table 3-3: Total HOV Facility O&M Costs (2009 Dollars)

	Existing HOV	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Total Patrol Costs	\$200,400	\$111,400	\$61,500	\$31,900	\$ 405,200
Total Roadway Maintenance Costs	\$142,560	\$113,400	\$62,640	\$32,400	\$ 351,000
Total Cost O&M Costs	\$342,960	\$224,800	\$124,140	\$64,300	\$ 756,200
Cumulative Costs	\$342,960	\$567,760	\$691,900	\$756,200	